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**UTILITY
PATENT APPLICATION
TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. 6601-54075

First Inventor

Wei Ding & Andy C. Hung

Title

System & Method for Deinterlacing
Video Signal for Display

Express Mail Label No.

EL550964111US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)
2. ☒ Applicant claims small entity status.
See 37 CFR 1.27.
3. ☒ Specification [Total Pages 16]
(preferred arrangement set forth below)
- Descriptive title of the invention
 - Cross Reference to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to sequence listing, a table, or a computer program listing appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
4. ☒ Informal Drawing(s) (35 U.S.C. 113) [Total Sheets 7]
5. Oath or Declaration [Total Pages 3]
- a. ☒ Newly executed (original or copy)
- b. ☐ Copy from a prior application (37 CFR 1.63 (d))
(for continuation/divisional with Box 17 completed)
- i. ☐ **DELETION OF INVENTOR(S)**
Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. ☐ Application Data Sheet. See 37 CFR 1.76

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Box Patent Application
Washington, DC 20231

7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
- a. ☐ Computer Readable Form (CRF)
- b. Specification Sequence Listing on:
- i. ☐ CD-ROM or CD-R (2 copies); or
- ii. ☐ paper
- c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. ☐ Assignment Papers (cover sheet & document(s))
10. ☐ 37 CFR 3.73(b) Statement (when there is an assignee) ☐ Power of Attorney
11. ☐ English Translation Document (if applicable)
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
13. ☐ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. ☐ Other:

17. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP)

of prior application No. _____ / _____

Prior application information.

Examiner _____

Group / Art Unit. _____

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

18. CORRESPONDENCE ADDRESS☐ Customer Number or Bar Code Label

(Insert Customer No. or Attach bar code label here)

or ☐ Correspondence address below

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City	San Francisco	State	California	Zip Code	94111
Country	USA	Telephone	415-986-1300	Fax	415-986-0320

Name (Print/Type)

Donald L. Bartels

Registration No. (Attorney/Agent)

28,282

Signature

Date Oct. 20, 2000

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**FEE TRANSMITTAL
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TOTAL AMOUNT OF PAYMENT (\$) 395.00**Complete if Known**

Application Number	Unassigned
Filing Date	Concurrently herewith
First Named Inventor	Wei Ding & Andy C. Hung
Examiner Name	Unassigned
Group Art Unit	Unassigned
Attorney Docket No.	6601-54075

METHOD OF PAYMENT

- 1.
- ☒
- The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

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Deposit Account Name **COUDERT BROTHERS**

☒ Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17☐ Applicant claims small entity status See 37 CFR 1.27

- 2.
- ☒
- Payment Enclosed:**

☒ Check ☐ Credit card ☐ Money Order ☐ Other**FEE CALCULATION****1. BASIC FILING FEE**

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)		
101	710	201	355	Utility filing fee	355
106	320	206	160	Design filing fee	
107	490	207	245	Plant filing fee	
108	710	208	355	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) (\$) 355.00**2. EXTRA CLAIM FEES**

Total Claims **15** -20** = **4** X **40** = **160**

Independent Claims **4** -3** = **1** X **40** = **40**

Multiple Dependent **1** X **40** = **40**

Large Entity		Small Entity		Fee Description
Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	
103	18	203	9	Claims in excess of 20
102	80	202	40	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	80	209	40	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$) 40.00

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FEE CALCULATION (continued)**3. ADDITIONAL FEES**

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code (\$)	Fee Code (\$)	Fee Code (\$)	Fee Code (\$)		
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for <i>ex parte</i> reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	390	216	195	Extension for reply within second month	
117	890	217	445	Extension for reply within third month	
118	1,390	218	695	Extension for reply within fourth month	
128	1,890	228	945	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,240	241	620	Petition to revive - unintentional	
142	1,240	242	620	Utility issue fee (or reissue)	
143	440	243	220	Design issue fee	
144	600	244	300	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	710	246	355	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	710	249	355	For each additional invention to be examined (37 CFR § 1.129(b))	
179	710	279	355	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify) _____

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$) _____**SUBMITTED BY**

Name (Print/Type)	Donald L. Bartels	Registration No. (Attorney/Agent)	28,282	Telephone	415-986-1300
Signature	<i>Donald L. Bartels</i>	Date	Oct. 20, 2000		

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s) or Patentee(s): Wei Ding, et al.
Application No. or Patent No.: Unknown
Filed or Issued: Herewith
For: SYSTEM AND METHOD FOR DEINTERLACING
A VIDEO SIGNAL FOR DISPLAY ON
PROGRESSIVE DISPLAY DEVICES

**VERIFIED STATEMENT (DECLARATION) CLAIMING
SMALL ENTITY STATUS (37 C.F.R. §§ 1.9(f)
AND 1.27(c)) - SMALL BUSINESS CONCERN**

I hereby declare that I am

() the owner of the small business concern identified below:
(X) an official of the small business concern empowered to act on behalf of the
concern identified below:

NAME OF CONCERN: Intervideo, Inc.
ADDRESS: 47350 Fremont Blvd.
Fremont, CA 94538

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 C.F.R. § 121.3-18, and reproduced in 37 C.F.R. § 1.9(d), for purposes of paying reduced fees under § 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled SYSTEM AND METHOD FOR DEINTERLACING A VIDEO SIGNAL FOR DISPLAY ON PROGRESSIVE DISPLAY DEVICES

by inventor(s) Wei Ding and Andy C. Hung described in

(x) the specification filed herewith
() application Serial No. _____, filed _____.
() Patent No. _____, issued _____.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 C.F.R. § 1.9(d) or by any concern which would not qualify as a small business concern under 37 C.F.R. § 1.9(d) or a nonprofit organization under 37 C.F.R. § 1.9(e).

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 C.F.R. § 1.27)

Full Name:

Address:

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

Full Name:

Address:

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

Full Name:

Address:

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate (37 C.F.R. § 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Name of person signing: Chinn Chin, Vice President of Engineering

Address of person signing: 47350 Fremont Blvd.
Fremont, CA 94538

Signature:

Date:

October 16, 2000

SYSTEM AND METHOD FOR DEINTERLACING A VIDEO SIGNAL FOR DISPLAY ON PROGRESSIVE DISPLAY DEVICES

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FIELD OF THE INVENTION

The present invention generally relates to digital media players and, more particularly, to a system and method for detecting interlaced video signals and processing such signals to make them viewable on progressive display devices.

BACKGROUND OF THE INVENTION

Conventional video signals provided from a standard television camera (NTSC signal) or a standard video camera are comprised of a series of frames. Each frame is comprised of two fields (top and bottom) having opposite polarity. Each field contains a series of pixels that contain data representative of the image present in each frame. The frames are interlaced in such a fashion that the top and bottom fields are configured either in sequential order as illustrated in Figure 1(a), or adjacent to one another as illustrated in Figure 1(b). The two fields represent images captured at different times. These interlaced frames represent the figures that are displayed on a suitable display device such as, for example, a television screen.

To maintain the image quality of a moving figure, an NTSC signal, for example, can only be displayed on an interlaced monitor such as a television screen or equivalent RGB screen. When images comprised of NTSC signals are displayed on progressive display devices, i.e. computer monitors, without processing, the frames that provide an NTSC image of a moving object such as, for example, the glass illustrated in Figure 2(a)

will appear on the progressive display devices as having jagged edges (or artifacts) as illustrated in Figure 2(b).

SUMMARY OF THE INVENTION

The present invention is directed to a video display system and associated processing method that is capable of removing artifacts from a video signal, resulting in a filtered video signal that is capable of being displayed on progressive display devices.

The artifacts are removed from an input video signal in a frame by frame fashion. Frame processing is performed in one of two fashions: (1) based on the information contained in each individual frame or (2) by an interpretive process based on the processing performed on a preceding number of adjacent frames. In an exemplary embodiment, artifacts are removed from an input video signal by: (a) obtaining the current frame information from an input video signal; (b) detecting the current frame delimiter from the input video signal; (c) determining whether the current frame is within a predetermined time interval; (d) determining the type of processing to be performed within the time interval from a corresponding table; and (e) generating a video frame signal in response to the predetermined parameters contained in the table.

In an alternate embodiment, artifacts are removed from an input video signal by: (a) separating a video image frame into its component fields; (b) determining which of the component fields is a first component field; (c) discarding the second component field of the video image frame; and (d) generating a combined video image frame signal based solely on the first component field.

The aforementioned signal processing steps are performed by a larger digital video system comprising a navigation unit operative to isolate an input video signal present on a digital media element provided therein; and a video unit operative to process the isolated video signal such that the video signal can be displayed on a progressive display device, the video unit comprising a decoder for separating the video signal into a plurality of frames, each frame containing a series of fields; and a video display module operative to process the fields based on information contained within each of the plurality of frames. In an exemplary embodiment, the video display module further includes a detection unit operative to determine the type of processing to be performed on the input video signal based on the fields.

An advantage of the present invention is that it provides the ability to view a conventional digital image on progressive display devices.

Another advantage of the present invention is that it provides the ability to process a conventional digital image during run time.

5 Still another advantage of the present invention is that it is simple to implement.

Yet still another advantage of the present invention is that it improves video signal processing efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

10 The aforementioned and related advantages and features of the present invention will become apparent upon review of the following detailed description of the invention, taken in conjunction with the accompanying drawings, where like numerals represent like elements, in which:

15 Figures 1(a) -1(b) are schematic representations of the components of a video signal;

Figure 2(a) is a schematic representation of an image provided on a conventional display device based on a conventional video signal;

Figure 2(b) is a schematic representation of the image illustrated in Figure 2(a) as displayed on a progressive display device;

20 Figure 3 is a schematic diagram of a video display system according to the present invention;

Figure 4 is a block diagram of the detection and processing units of the video display module according to the present invention;

25 Figure 5 is a flow chart of the operating steps performed by the video display module during initialization of the video display system;

Figure 6 is a flow chart of the operating steps performed by the video display module during run time of the video display system;

Figure 7 is a flow chart of the operating steps performed by the video display module during content based detection;

30 Figure 8 is a flow chart of the operating steps performed by the video display module during bit-stream based detection;

Figure 9 is an illustration of WEAVE processing as performed on a digital video frame signal by the video display module according to the present invention;

Figures 10(a) - 10(c) illustrates BOB processing as performed on a digital video frame signal by the video display module according to the present invention;

5 Figure 11 illustrates BOB processing as performed on a digital video frame signed by the video display module according to an alternate embodiment of the present invention;

10 Figure 12 is a schematic representation of an image as displayed on a progressive display device based on the filtered video signal generated by the video display module of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

15 The video display system of the present invention will now be described with reference to Figures 3-12. In an exemplary embodiment of the present invention, the digital video display system comprises a digital versatile disk (DVD) player 10, including a navigation unit 12 coupled to a video unit 14. The video unit 14 provides a filtered video signal to a progressive display device 20 on line 21. In a preferred embodiment, the progressive display device 20 is a computer monitor. The video unit 14 includes a decoder 15 and a video display module 18. The video display module 18 performs the
20 detection and signal processing functions of the present invention and provides the filtered video signal on line 21.

The navigation unit 12 accepts a digital media element such as, for example, a digital versatile disk 11 and is capable of providing the audio information stored on the versatile disk 11 on a first data line (AUDIO) the video information stored on the
25 versatile disk 11 on a second data line (VIDEO), and any additional information stored on the versatile disk 11 on a third data line (ADDDT'L). In operation, the navigation unit 12 is also capable of providing the current playback position of the versatile disk 11 being played by the DVD player 10 on line 22.

30 The video information present on the VIDEO line is transferred to the video unit 14 through the decoder 15. The decoder 15 is capable of separating the input video signal into a plurality of frames that make-up the input video signal. The plurality of

frames have the same structure as the frames illustrated in Figure 1(b). The video frames are then transferred to the video display module 18 for processing.

The video display module 18 is comprised of a detection unit 16 (Figure 4) and a processing unit 17 (Figure 4). The detection unit 16 is capable of detecting the presence of a new video frame from the signal provided by the decoder 15 and to determine the type of processing (or filtering) that should be performed on such video frame. After determining the appropriate type of processing that needs to be performed on any given frame, such processing is then performed in the processing unit 17. In operation, the processing unit 17 performs two types of filtering on the video frame: (1) WEAVE signal processing (Figure 9); or (2) BOB signal processing (Figure 10). The appropriately filtered video frame is then provided to the computer monitor 20 on line 21.

The operation of the DVD player 10 of the present invention will now be described with reference to Figures 5-11. Figure 5 is a flow chart of the operating steps performed by the video display module 18 of the present invention during initialization of the DVD player 10. The initialization routine illustrated in Figure 5 is performed every time a versatile disk 11 is inserted into the navigation unit 12. In a first step 50 a Volume table is generated for the versatile disk being played. The Volume table is a database, or suitable look-up table, containing entries relating to the filtering that needs to be performed on the frames which comprise the images present on the versatile disk 11.

Table 1 illustrates an exemplary Volume table.

DVD Volume Title	Title No.	Chapter	Start Time	End Time	ProceSSION Decision
INTERVIDEO	1	1	T _A	T _B	BOB
INTERVIDEO	1	2	T _C	T _D	WEAVE

Table 1

As shown, in Table 1, the contents of the Volume table are indicative of the type of filtering that must be performed on the various frames that comprise the video signal that is present on the versatile disk 11. More specifically, the Volume table contains information on the title of the video being played, the frame number being currently

played, the length of the frame being played and the type of filtering required to be performed on the frame during a given time interval.

After the Volume table has been generated, in step 52 the DVD player 10 next detects the presence of an entry in the Volume table which corresponds to the information (i.e. movie title) stored on the versatile disk 11. If the Volume table contains an entry which matches the title of the versatile disk 11, the processing (filtering) information maintained in the memory of the processing unit 17 (Figure 4) is updated. If no match is detected, the particular entry in the Volume table is set to zero in step 54.

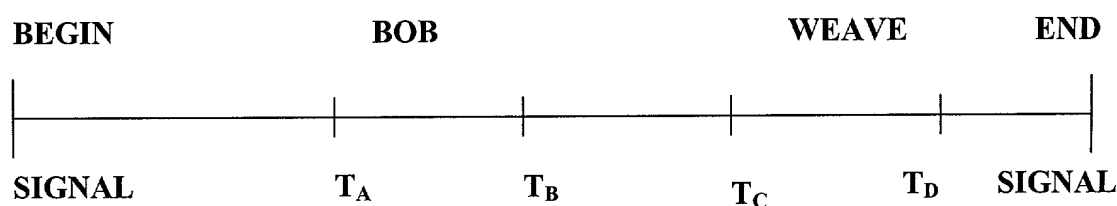
After initialization has been completed, the DVD player 10 knows what type of filtering needs to be performed on the input video signal during run time and when such filtering is to be performed. The DVD player 10 then enters the run time (or playback) phase of operation. Figure 6 is a flowchart of the operating steps performed by the video display module 18 of the present invention during run time. At a first step 60, and at a predetermined time intervals during the playback of the versatile disk 11, the detection unit 16 (Figure 4) of the video display module 18 checks whether the user has selected a particular type of video processing to be performed on the current frame. If the user has made a selection, control is then transferred to the selected video processing module at step 61. After control has been transferred in step 61, where appropriate, processing (BOB or WEAVE) are performed, as specified by user selection.

If no user selection was made or auto detection was selected in step 60, a determination as to whether content based detection should be performed on the current frame is made in step 62. If content based detection is to be performed on the current frame, control is then transferred to the content based detection module in step 70. If content based detection is not to be performed on the current frame, control is then transferred to the bit-stream based detection module in step 80. The content based detection algorithm and bit-stream based detection algorithm will be described in greater detail below.

As illustrated in Figure 7, when content based detection is to be performed on the current frame, the detection unit 16 of video display module 18 retrieves the current playback position of the versatile disk 11 from the navigation unit 12. Next, the current title, chapter and frame time of the video being played are stored in the variables title_c,

chapter_c and time_c, respectively in step 71. The current title_c, chapter_c and time_c information is obtained from the navigation unit 12 approximately every 30 ms. Next, in step 72, a determination is made as to whether there is a match between title_c, chapter_c and time_c and the data present in the Volume table generated during initialization. If there is a title and chapter match and time_c is between a predetermined start (start_time_v) and end (end_time_v) time in step 74, then the type of processing to be performed on the current frame is that provided by the Volume table in step 76.

Next, control is then transferred to the processing unit 17 (Figure 4) where the particular type of signal processing listed in the Volume table, either BOB processing or WEAVE processing, is performed on the current frame. For example, referring to Table 1 provided above, by employing the content based detection algorithm of the present invention, the processing unit 17 will know that BOB processing is to be performed on the frame displayed during the T_B - T_A time period and that WEAVE processing is to be performed on the frame being displayed during the T_D - T_C time period as shown on the timeline below.



On the other hand, if no Volume table match is detected in step 72, control is then passed to the bit-stream detection algorithm in step 73 where bit-stream based detection is performed on the current frame. This content based detection scheme is very precise in that the particular type of video signal processing to be performed on a given frame is provided directly from the frame data contained within the Volume table. No additional calculations are required. In experiments performed by the inventors, processing of video frames using content based detection yielded images that have much better visual quality than conventional video frame signals.

Bit-stream based detection will now be described with reference to Figure 8. As illustrated in greater detail in Figure 8, when control is transferred to the bit-stream based

detection algorithm, the detection unit 16 of the video display module 18 retrieves the current frame information from the decoder unit 15. For each frame, an interlace indicator I_N is calculated in step 81 based on the following boolean expression:

$$I_N = \text{NOT} ((\text{picture_structure} = \text{FRAME_PICTURE}) \text{ AND } \text{progressive_frame})$$

where picture_structure is a variable obtained from the frame information contained on the versatile disk 11 and represents the structure of the current frame. More specifically, the picture_structure variable can have one of three values: FRAME_PICTURE, TOP_FIELD or BOTTOM_FIELD. Variables TOP_FIELD and BOTTOM_FIELD indicate which field of the current video frame is first. FRAME_PICTURE is a variable which indicates that the current frame is not separated into fields. Variable progressive_frame is obtained from the frame information contained on the versatile disk 11 and is an indicator as to whether the current frame can be displayed on a progressive display device without any further processing. When progressive_frame has a value of 1 (true), this indicates that the present frame is already in a proper format to be displayed on a progressive display device. If progressive_frame is zero (false), this indicates that some type of processing (either BOB or WEAVE) needs to be performed on the current frame. The relationship between I_N and the progressive_frame variable is represented graphically in Table 2 below.

I_N	progressive_frame	picture_structure
1	0	_____
0	1	FRAME_PICTURE

TABLE 2

After I_N has been calculated in step 81, it is stored as the last entry in a first in first out (FIFO) memory in step 82, along with the calculated I_N values of the three immediately preceding frames. Next, in step 84, a decision is made using the four stored I_N values regarding what type of processing is to be performed on the current frame based on the following boolean condition:

$$(I_N=\text{TRUE}) \text{ AND } (I_{N-1}=\text{TRUE}) \text{ AND } (I_{N-2}=\text{TRUE}) \text{ AND } (I_{N-3}=\text{TRUE})$$

Thus, if I_N , I_{N-1} , I_{N-2} and I_{N-3} are all 1 (TRUE), then control is transferred to processing unit 17 where BOB processing will be performed on the current frame in step 85.

On the other hand, if any of the I_N values are a zero (false), then control will be transferred to the processing unit 17 where WEAVE processing will be performed on the current frame in step 86. In the bit-stream detection method described above, I_N is calculated for every frame, and the decision as to the type of processing to be performed on the current frame is always determined by comparing the current I_N with the interlace indicator values of the three immediately preceding frames (I_{N-1} , I_{N-2} , and I_{N-3}).

The signal processing that is performed by the processing unit 17 of the present invention will now be described with reference to Figures 9 and 10. Figure 9 is an illustration of WEAVE processing that is performed on a video frame signal. As shown in greater detail in Figure 9, the current frame to be processed is separated into two fields: a top field, which in a preferred embodiment is represented by field lines 0, 2, 4, 6...N-1, and a bottom field represented by field lines 1,3,5,7,...N. In WEAVE processing, artifacts are removed from the current frame by taking the out of bound values (present in the pixels that comprise the field lines) and placing them within the proper field line. More specifically, as shown in Figure 9, WEAVE processing takes the adjacent fields and concatenates them into a single video frame containing field lines 0-N.

Figure 10 illustrates BOB processing that is performed on a current frame signal by the processing unit 17. In BOB processing, the current frame is first separated into its two respective fields (Fig. 10(a)). Next, a determination is made as to which of the respective fields occurs first. To determine whether the bottom field is the first frame field, the following boolean condition must be satisfied:

$$\text{bBottomFirst} = ((\text{picture_structure} = \text{FRAME_PICTURE}) \text{ AND } (\text{NOT top_field_first}))$$
$$\text{OR } (\text{picture_structure} = \text{BOTTOM_FIELD})$$

Thus, if variable `picture_structure` is set to `BOTTOM_FIELD`, then `bBottomFirst` is true. Also, if `picture_structure` is set to `FRAME_PICTURE`, indicating the current frame is not separated into fields, and `top_field_first` is not set, then `bBottomFirst` is also true.

If bBottomFirst is true, then the bottom field is used to construct the resulting video frame. Otherwise, the top field is used to construct the resulting video frame.

As illustrated by the boolean pseudocode above, BOB processing first determines which of the two frame fields is first. That first field is then used to generate the resulting video frame as illustrated in Figures 10(b) and 10(c). Figure 10(b) represents the situation where the first field is the top field represented by field lines 0, 2, 4, 6,...N-1. As shown in Figure 10(b), when the top field is the first field, the bottom field is discarded and the resulting video frame is constructed as follows: the first frame line is field line 0. The second frame line contains the average of the pixel values present in field line 0 and field line 2. The third frame line is field line 2. The fourth frame line contains the average of the pixel values present field line 2 and field line 4. The fifth frame line is field line 4. The sixth field line contains the average of the pixel values present in field line 4 and field line 6. The remaining field lines are generated as discussed above until the video frame is completed by having the last frame line be the last (or bottom field line) of the first selected frame. Thus, resulting frame lines 1,3,5, ... N-1 contain values representative of the average pixel values contained in adjacent frame lines.

Figure 10(c) illustrates the resulting frame when the bottom field is the first field. The resulting frame is constructed as follows: the first and second frame lines are represented by field line 1. The third frame line is a field line containing a value that is the average of the pixel values present in the second frame line (field line 1) and field line 3. Frame line 4 is represented by field line 3. Frame line 5 contains the average of the pixel values present in field line 3 and field line 5. The generation of the calculated field lines continues through the last frame line which is represented by original field line N. Thus, when the bottom field is the first field, the first two field lines of the resulting video frame are represented by the top field line of the original video frame.

In an alternate embodiment of the present invention, the resulting video frame generated as a result of BOB processing can be represented as an n-tap low pass filter as illustrated in Figure 11, where the pixel values of the intermediary frame lines X_N are represented as follows:

$$X_N=(c_3X_{n-3} + c_1X_{n-1} + c_1X_{n+1} + c_3X_{n+3})/(c_1 + c_3 + c_3 + c_1)$$

where c_3 and c_1 are constants which are used to provide a weighted average for the pixels represented by X_{n-3} , X_{n-1} , X_{n+1} and X_{n+3} . In experiments performed by the inventors, it was determined that $c_1=3$ and $c_3=1$ provides the optimum values for the resulting video frame.

Upon completion of either the BOB or WEAVE processing, the artifacts from each frame of the video signal will have been removed, thereby resulting in an image being displayed on a progressive display device, such as a computer monitor, having no jagged edges as illustrated in Figure 12.

The foregoing detailed description of the invention has been provided for the purposes of illustration and description. Although an exemplary embodiment of the present invention has been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to the precise embodiment disclosed, and that various changes and modifications to the invention are possible in light of the above teaching. Accordingly, the scope of the present invention is to be defined by the claims appended hereto.

CLAIMS

WHAT IS CLAIMED IS:

1. A digital video display device, comprising:
 - a navigation unit operative to isolate an input video signal;
 - 5 a video unit operative to process said input video signal such that said input video signal can be displayed on a progressive display device, said video unit comprising:
 - a decoder operative to separate said input video signal into a plurality of frames, each frame containing a series of fields; and
 - 10 a video display module comprising a detection unit operative to determine the type of processing to be performed on said input video signal based on information contained within each of said plurality of frames.
2. The system of Claim 1, wherein said video display module further
15 includes a processing unit operative to provide a filtered digital video frame signal based on said fields.
3. The system of Claim 1, wherein said detection unit is operative to
20 determine the type of processing to be performed on a video frame signal based on particular field data contained within said video frame signal.
4. The system of Claim 1, wherein said detection unit is operative to
25 determine the type of processing to be performed on a video frame signal based on the field data of a predetermined number of prior video frames and said video frame signal.
5. The system of Claim 4, wherein said predetermined number of prior video frames is three.

5 6. The system of Claim 2, wherein said processing unit further comprises a first processing module operative to provide a digital video frame that is a concatenation of fields of an input data frame, and a second processing module operative to provide a digital video frame containing field segments having values based on adjacent field segments.

10 7. The system of Claim 3, wherein said particular field data is stored in a table, said table containing the type of processing to be performed on said video frame signal.

15 8. A digital video display system, comprising:
a navigation module operative to isolate an input video signal present in a digital medium;
a decoder operative to separate said input video signal into a plurality of video frames;
a detection module operative to detect the type of processing to be performed on said video frame, said detection module including a table which provides the type of processing to be performed on said video frame in response to the current video frame position; and
20 a processing module operative to provide a filtered video frame in response to information contained in said table, wherein said filtered video frame is capable of being displayed on a progressive display device.

25 9. The system of Claim 8, wherein said processing module further comprises a first module operative to provide a video frame signal that is a concatenation of the fields of an input video frame, and a second module operative to provide a video frame signal containing field segments having values based on the values of adjacent field segments.

10. The system of Claim 8, wherein said detection module is operative to determine the type of processing to be performed on said video frame based on field data of a predetermined number of prior video frames and said video frame.

5 11. The system of Claim 10, wherein the predetermined number of prior video frames is three.

12. A video signal processing method, comprising the steps of:

10 (a) obtaining current video information from an input video signal;
(b) detecting the current frame delimiter from said input video signal;
(c) determining whether said current frame is within a predetermined time interval;

(d) determining the type of processing to be performed on said current frame from a corresponding data table;

15 (e) generating a video frame in response to predetermined parameters in said data table.

13. The processing method of Claim 12, wherein said predetermined parameters are frame dependent.

20 14. A method of processing a video signal to remove artifacts, comprising the steps of:

(a) separating a video image frame into its component fields;
(b) determining which of said component fields is the first component field;

25 (c) discarding the second component field of said video image frame;
and

(d) generating a combined video image frame signal based only on said first component field.

30

15. The method of Claim 14, wherein step (d) comprises the steps of:
- (d1) separating said first component field into alternating pixel lines;
 - (d2) generating a pixel line having a value comprising the average of said alternating pixel lines; and
 - (d3) providing said generated pixel line between said alternating pixel lines.

5

Continued on next page

[illegible]

5

10

TOP
FIELD

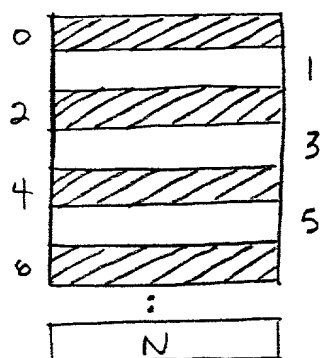


FIG 1(a)

BOTTOM
FIELD

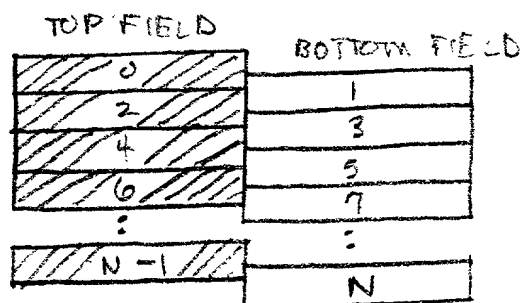


FIG 1(b)

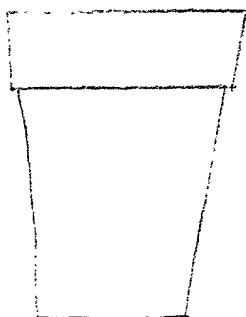


FIG 2(a)

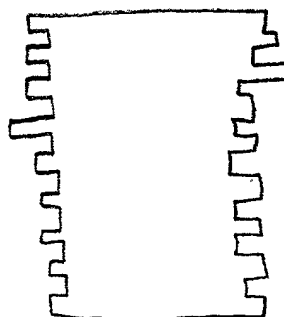
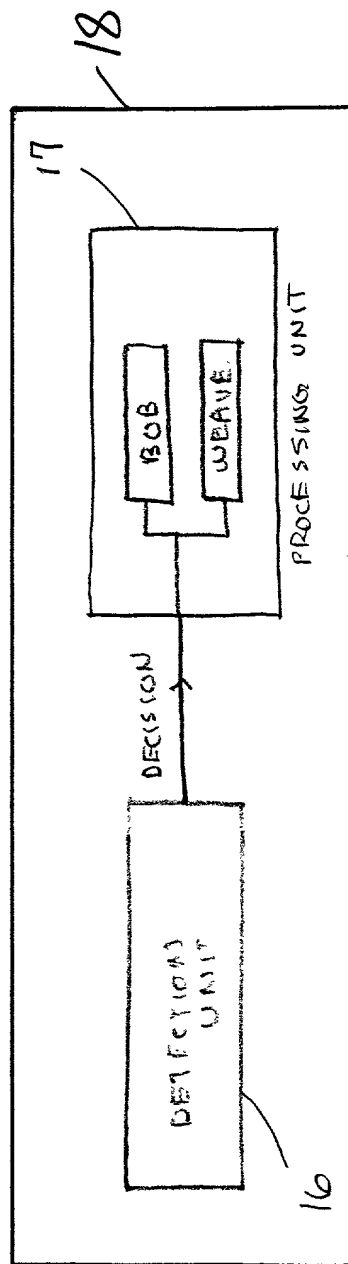
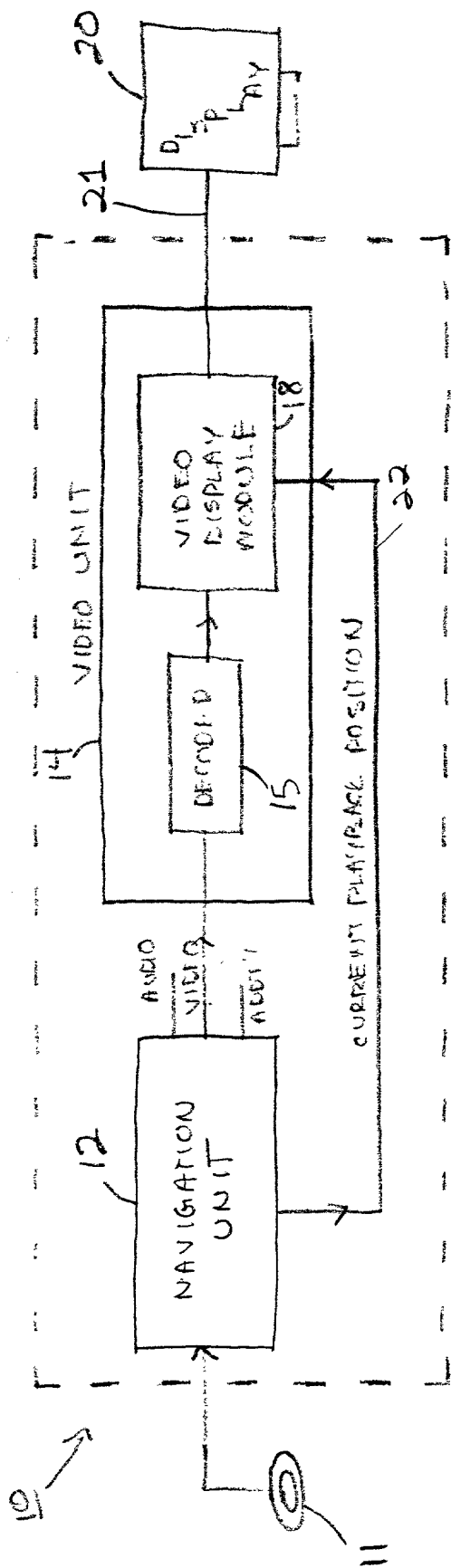
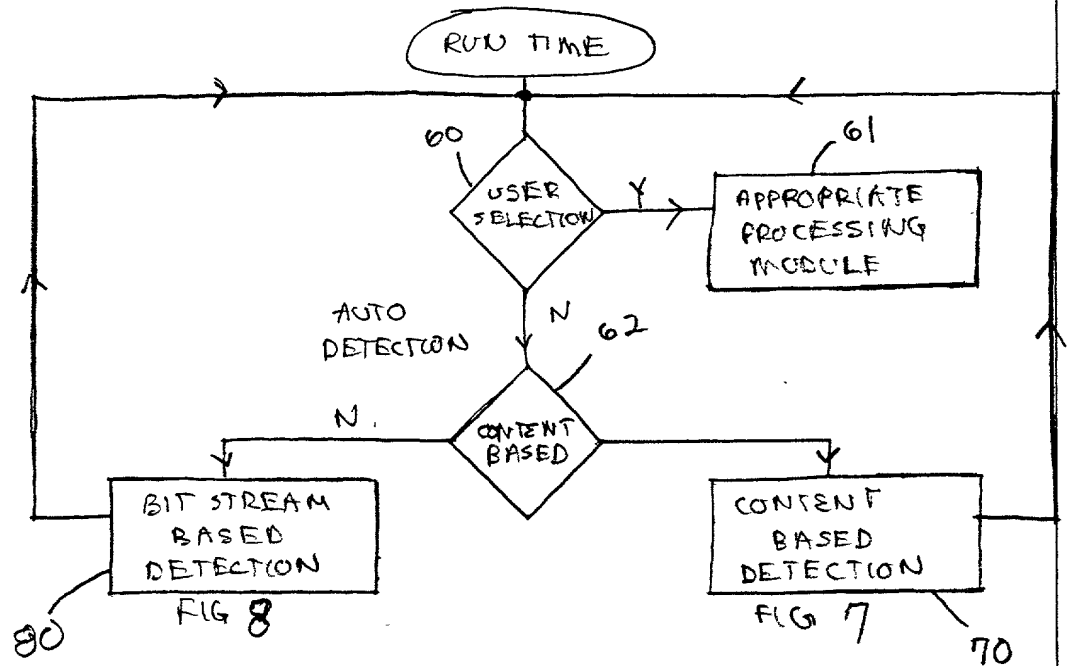
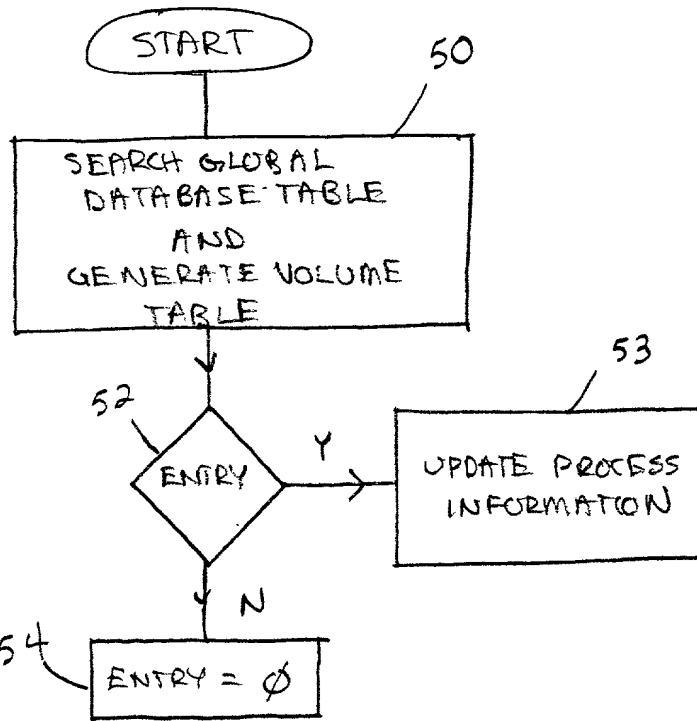


FIG 2(b)





FROM FIG. 6

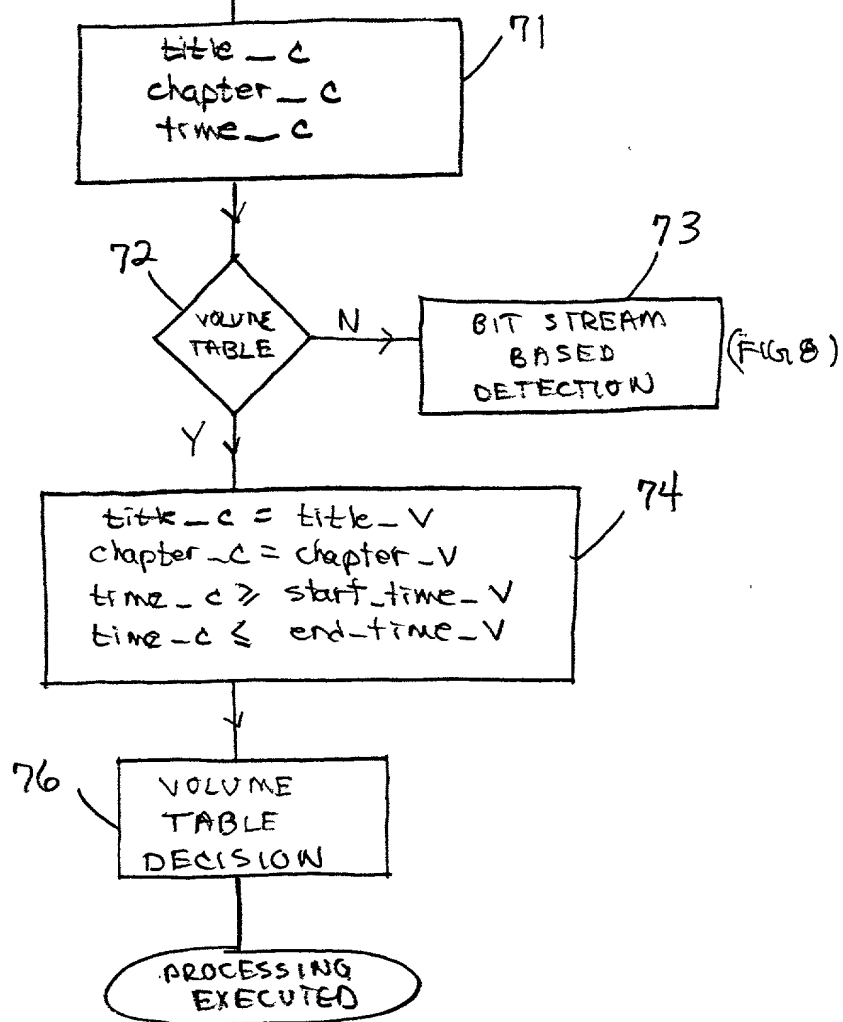


FIG. 7

FROM FIG. 6

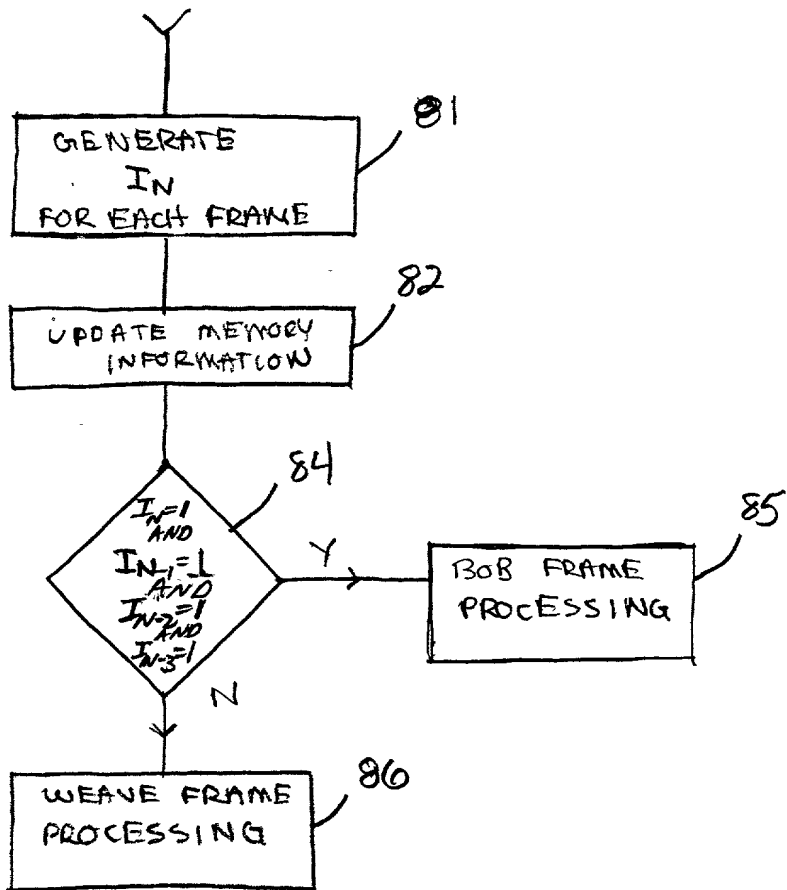


FIG 8

WEAVE PROCESSING

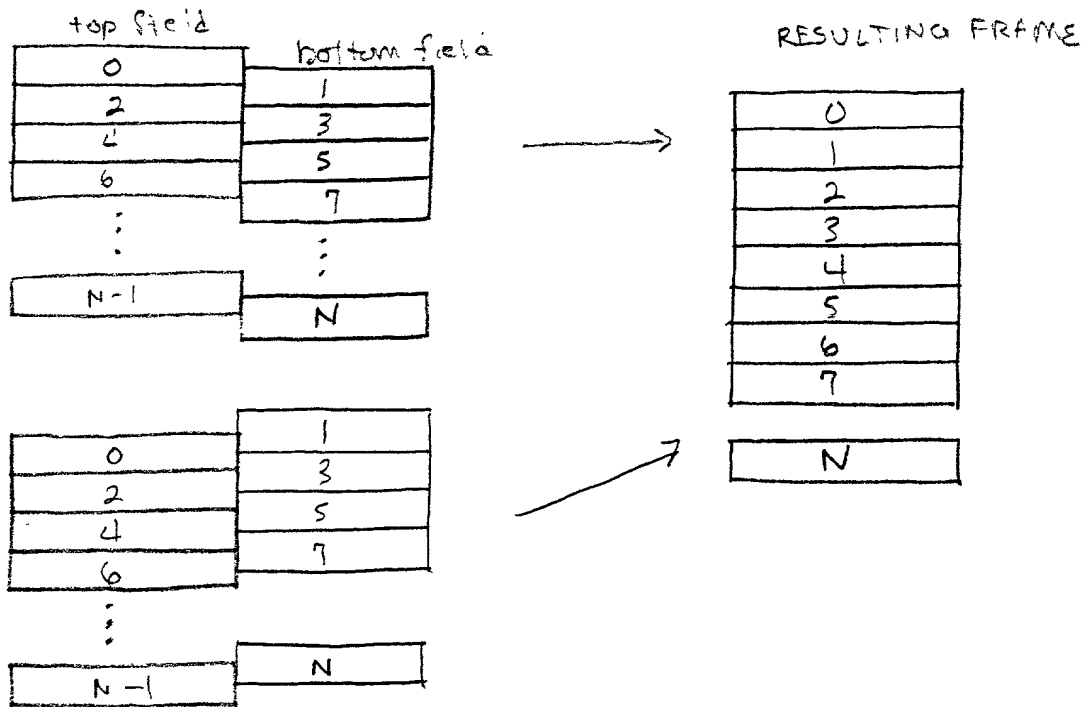


FIG 9

BOB PROCESSING

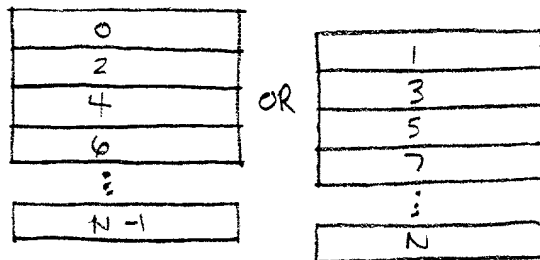


FIG 10(a)

TOP FIELD FIRST

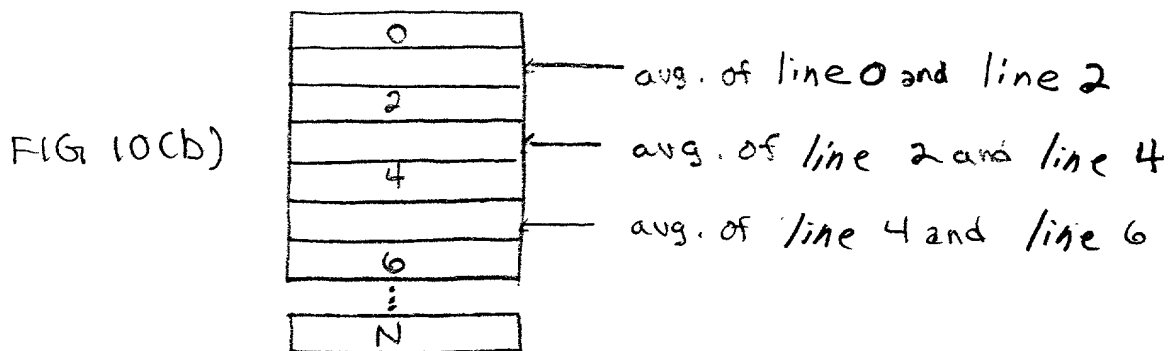


FIG 10(b)

BOTTOM FIELD FIRST

FIG 10(c)

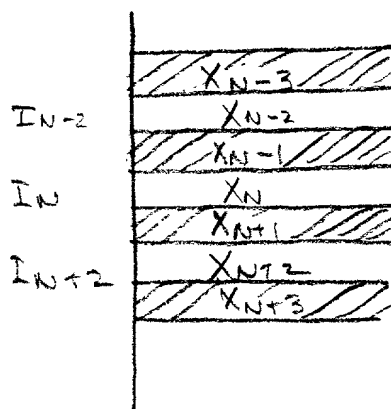
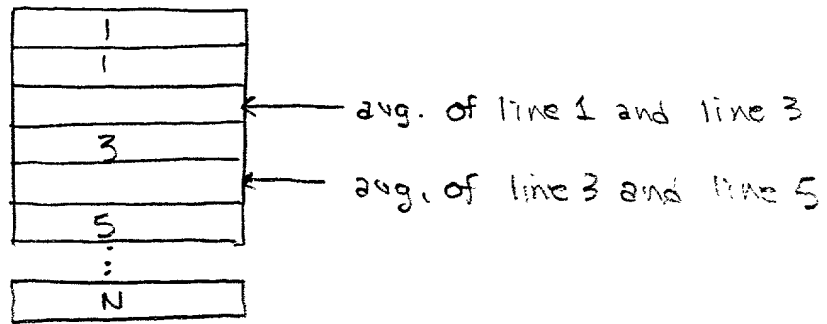


FIG 11

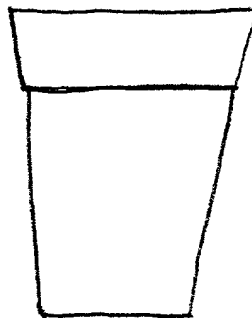


FIG 12

DECLARATION FOR PATENT APPLICATION

As below named inventors, we hereby declare that:

Our residence, post office address and citizenship are as stated below next to our name.

We believe we are an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SYSTEM AND METHOD FOR DEINTERLACING A VIDEO SIGNAL FOR DISPLAY ON
PROGRESSIVE DISPLAY DEVICES

the specification of which (check one)

- ☒ is attached hereto.
☐ was filed by an authorized person on my behalf on
_____ as Application Serial No. _____
and was amended on _____.
(if applicable)

We hereby state that we have reviewed and understand the contents of the above-identified specification, including the claims as amended by any amendment referred to above.

We acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

We hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and so identified, and we have also identified below any foreign application for patent or inventor's certificate on this invention filed by us or our legal representatives or assigns and having a filing date before that of the application on which priority is claimed.

<u>Number</u>	<u>Country</u>	<u>Day/Month/Year Filed</u>	<u>Priority Claimed (Yes or No)</u>
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NONE

We hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, we acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international

filing date of this application:

Application Serial No.
NONE

Filing Date

Status

We hereby declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.


We hereby appoint the following attorneys and patent agent, with full power of substitution and revocation, to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith and request that all correspondence and telephone calls in respect to this application be directed to COUDERT BROTHERS, 4 Embarcadero Center, Suite 3300, San Francisco, CA 94111, Telephone No. (415) 986-1300:

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